

**REMARKS**

Claims 1-12, 14-24, 26-27 and new claims 28-34 are currently are pending. Claims 1-10, 12, 14-24, 26 and 27 have been allowed. Applicants thank the Examiner for the prompt indication of their allowance. Claims 13 and 25 have been cancelled.

New claims 28 and 29 recite the particle diameter of the particulate noble metal to be 200nm or less (or 100nm or less) and also recite the particle diameter of the particulate rare-earth oxide to be 500nm or less. Additional relevant portions of the specification in support of the same are reproduced below:

Particularly, the particle diameter is preferably 200nm or less, more preferably 100nm or less. If the particle diameter is too large, i.e. more than 200nm, the surface area of the [particulate] noble metal, which is the main catalyst, is decreased, [then] the satisfactory oxygen reduction activity [is] unable to be achieved. Also, when the size of the [particulate] rare-earth oxide fixed to the carrier decreases, the number of active sites is increased. Particularly, the particle diameter is preferably 500nm or less. If the particle diameter is too large, i.e. more than 500nm, the interface serving as the active site is less easily formed, and the satisfactory oxygen reduction activity is not achieved. [(Specification originally filed at page 11, lines 1-10; emphasis added.)]

New claim 30 recites that "the mixture is fixed to the conductive carrier" as noted in the **Listing of the Claims** section of this paper. (Emphasis added.) Support for being "fixed to" is found in the specification originally filed reciting (in relevant part):

According to the invention, as long as it is fixed to the carrier, a smaller noble metal particle, which is the main catalyst, is preferred because the total surface area of the noble metal is increased. [(Specification originally filed at page 10, lines 24-27; emphasis added.)]

Also, support for new claims 31-34 is found in the specification and claims originally filed.

Accordingly, no new matter (35 USC § 132) has been introduced.

**Rejection under 35 U.S.C. § 101**

Claims 13 and 25 are rejected under 35 U.S.C. § 101 for the reasons noted at page 2 of the non-final Office Action.

To expedite prosecution, Applicants have cancelled claims 13 and 25, rendering the issue of their rejection moot.

**Rejections under 35 U.S.C. § 102(b) over Nara et al. and separately over Nishiki**

Claim 11 is rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,312,571 to Nara et al., (hereinafter "Nara") for the reasons noted at pages 2-3 of the non-final Office Action.

Claim 11 is also rejected under 35 U.S.C. § 102(b) as being anticipated by European Patent No. 0 298 055 to Nishiki (hereinafter "Nishiki") for the reasons noted at pages 3-5 of the non-final Office Action.

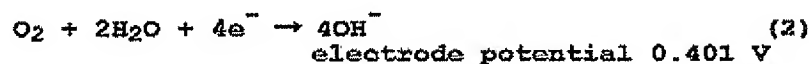
Applicants respectfully traverse these rejections for the reasons noted below.

The claimed invention relates to an electrode catalyst for oxygen reduction and a gas diffusion electrode using the electrode catalyst for oxygen reduction. This electrode is used in the brine electrolysis process using an oxygen reduction cathode, in which oxygen gas (as a starting material) is supplied to the cathode and reduced to hydroxide ion (OH<sup>-</sup>) by an oxygen reduction reaction.

By comparison, the electrode catalysts and active cathodes of Nara and Nishiki, respectively, contain a noble metal and one or more rare earth oxides as catalytic components. These catalysts and cathodes (of Nara and Nishiki, respectively) are used in the brine electrolysis process using a hydrogen generation cathode, in which water (as a starting material) is supplied to the cathode and simultaneously converted to the hydroxide ion (OH<sup>-</sup>) by removing a hydrogen atom for a hydrogen (H<sub>2</sub>) generation reaction.

The brine electrolysis processes by the hydrogen generation cathode system of Nara and Nishiki is compared to the oxygen reduction cathode system using the gas diffusion electrode of the presently claimed invention and explained below.

The hydrogen generation reaction at the hydrogen cathode, the oxygen reduction reaction at the gas diffusion electrode and the chlorine generation reaction at the anode are represented by the following chemical equations 1, 2 and 3, respectively:

**Hydrogen Generation Reaction (Nara and Nishiki)****Oxygen Reduction Reaction (claimed invention)**

**Chlorine Generation Reaction (at anode)**

In the brine electrolysis process, sodium ion ( $\text{Na}^+$ ) passes through an ion exchange membrane to move from the anode compartment to the cathode compartment. The total reaction equations of the hydrogen cathode system and the oxygen cathode system in which  $\text{Na}^+$  ion participates are the following equations (4) and (5), respectively.

**Hydrogen cathode system (Nara and Nishiki)****Oxygen cathode system (claimed invention)**

The theoretical electrolysis voltage is equivalent to a potential difference between the cathode reaction and the anode reaction. Therefore, the hydrogen cathode system requires 2.19 V, while the oxygen cathode system requires only 0.96 V. Consequently, the electrolysis voltage can be reduced by 1.23 V. For example, because the same anode is used, the difference in the electrolysis voltage is  $(0.828 + 0.401 = 1.23\text{V})$ . This is further explained on pages 2 – 3 of the specification originally filed.

An advantage of drastically reducing the electrolysis voltage (e.g., reducing by 1.23V) can be enjoyed by changing the reaction at the cathode from the Nara and Nishiki hydrogen generation reaction to the oxygen reduction reaction of the claimed invention yielding substantial energy savings being realized in the field of brine electrolysis. The electrode catalyst of the claimed invention is one for a gas diffusion electrode which is practically usable as a cathode for its energy-saving advantages in conjunction with brine electrolysis.

Differences between the present electrode and the prior art electrodes are summarized in the following table. Both are quite different in the types of electrodes, as noted from the electrode reaction (reaction equation) at the cathode, voltage used and conductive carrier used.

	Claimed Invention	Nara	Nishiki
Type of electrode	Gas diffusion electrode	Hydrogen generation electrode	
Reaction equation at cathode	Oxygen reduction reaction  $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-$	Hydrogen generation reaction  $2\text{H}_2\text{O} + 2\text{e}^- \rightarrow 2\text{OH}^- + \text{H}_2$	
Used voltage (V vs NHE)	+0.401 V	-0.828 V	
Conductive Carrier	Particulate carbon	Nickel mesh	

In view of the foregoing differences relating to the electrode catalyst of claim 11, Applicants respectfully submit that claim 11 has been patentably distinguished over Nara and Nishiki, respectively.

Because an anticipation rejection requires that each and every element/feature of a rejected claim be disclosed in a single applied reference and because Nara and Nishiki each fail to do so, for at least the foregoing reasons, Applicants respectfully request that the rejection of claim 11 under 35 USC § 102(b) over Nara and Nishiki, respectively, be reconsidered and withdrawn.

#### New Claims 28-29

New claims 28-29 recite various particle diameters for their novel and non-obvious advantages as described with respect to the non-limiting embodiments described at pages 10-11 of the specification originally filed. See portions of the specification reproduced above relating to the same.

Accordingly, Applicants respectfully submit that new claims 28-29 are also patentable over the references of record and request a written indication of the same.

#### New Claim 30

New claim 30 depends from claim 11. Thus, new dependent claim 30 is also patentable for the reasons that claim 11 is patentable.

Further, this dependent claim (depending from claim 11) further recites that "the mixture is fixed to the conductive carrier." (Emphasis added.) The term "fixed to the carrier" requires the mixture of the particulate noble metal and the particulate rare-earth oxide to be fixed directly to the carrier. (Emphasis added.)

By comparison, Nishiki interposes a nickel surface between the electrically conductive base and the platinum metal (noble metal) and the cerium oxide component (rare-earth oxide).

Accordingly, this claim is further patentable for these additional reasons.

**New Claims 31-33**

New claims **31 -33** each depend from claim **11**. Thus, new dependent claims **31-33** are also patentable for the reasons that claim **11** is patentable.

Moreover, new dependent claim **31** is directed to a process for preparing a gas diffusion electrode for brine electrolysis using the electrode catalyst of claim **11**. New dependent claim **32** is directed to a method for gas diffusion electrode-based brine electrolysis using the electrode catalyst of claim **11**. New claim **33** is also directed to gas-diffusion electrode based brine electrolysis using the electrode catalyst of claim **11**. In view of these features, claims **31-33** are patentable.

**New Claim 34**

New claim **34** depends from claim **11**. Thus, new dependent claim **34** is also patentable for the reasons that claim **11** is patentable.

Moreover, new dependent claim **34** expressly recites that "the electrode catalyst is suitable for an oxygen reduction reaction at a cathode in conjunction with a gas diffusion electrode for brine electrolysis". In view of the distinguishing and energy saving features noted in the Table above together with Applicants' remarks regarding the same, new claim **34** is also patentable.

**Conclusion**

In view of the foregoing, the Applicants respectfully submit that the application is in condition for allowance. A notice to that effect is respectfully requested.

If the Examiner believes that personal communication will expedite prosecution of this application, the Examiner is invited to contact the undersigned attorney at the number indicated.

Other than the excess claims fees (\$450.00), no additional fees are believed to be due. However, if any additional fees are required or an overpayment of fees made, please debit or credit our Deposit Account No. 19-3935, as needed.

Respectfully submitted,

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